Scalable and Distributed Inertial Navigation Systems, Phase I

Completed Technology Project (2018 - 2019)

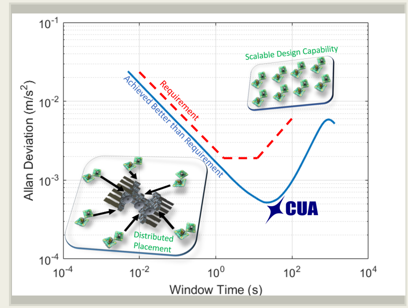
Project Introduction

Current state of the art inertial measurement units (IMUs) co-locate a set of accelerometers and gyroscopes into a single package. CU Aerospace (CUA), in partnership with the University of Illinois, propose to develop a scalable and distributed IMU for space robotics and CubeSat applications. The user can choose to include an arbitrary number of inertial sensors beyond the minimal number of sensors required for inertial navigation (3 gyroscopes and 3 accelerometers). This scalability enables both improved measurement resolution and system redundancy. The distributed nature of the system means that sensors can be placed arbitrarily by the user as needed in their design, under the constraint that each axis is measured by at least one accelerometer and gyroscope. This technology enables space-constrained systems to leverage redundant inertial sensors for fault detection and isolation (FDI). Beyond the systems engineering benefits of this system, distributing the sensors is grounded by previous research that suggests it will reduce the total noise of its output measurements. This technology can potentially be used in most robotic systems currently using an inertial navigation system. However, the best applications of this technology are in space constrained robots that can benefit from accurate state estimates or fault tolerant systems.

Anticipated Benefits

Distributed and scalable inertial measurement units can enable missions where MEMS components are failure prone. The technology provides emerging areas of CubeSat robotics and assembled structures with flexible in system layout. This technology can be used to reduce sensor noise while efficiently using space for human assisted robots aboard the international space station and or on autonomous or human assisted terrestrial rovers.

The best applications of this technology, however, is in space constrained robots that can benefit from accurate state estimates or fault tolerant systems. For example, in the natural gas industry, improved state estimates will translate into a better ability to pinpoint the location of problems prior to the excavation of a pipeline. Our concept can also improve pedestrian location technology by leveraging IMUs on multiple wearable devices for dead reckoning.



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Small Business Innovation Research/Small Business Tech Transfer

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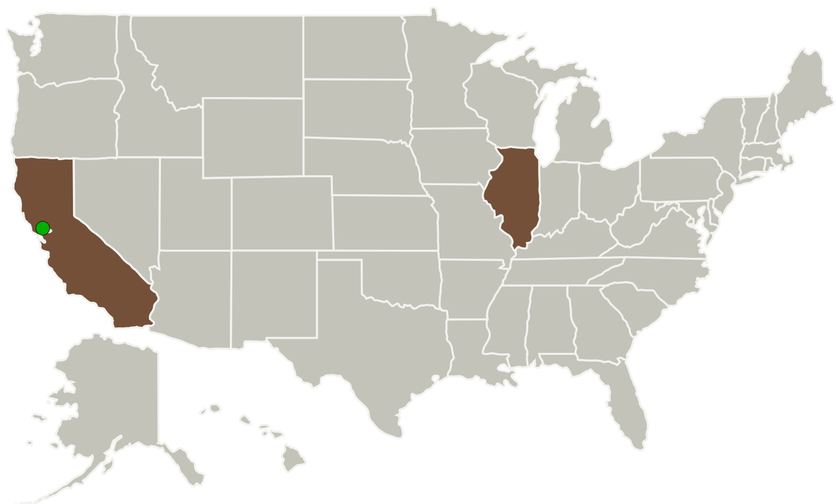
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
CU Aerospace, LLC	Lead Organization	Industry	Champaign, Illinois
Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California
University of Illinois at Urbana-Champaign	Supporting Organization	Academia	Urbana, Illinois

Primary U.S. Work Locations	
California	Illinois

Project Transitions

July 2018: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CU Aerospace, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

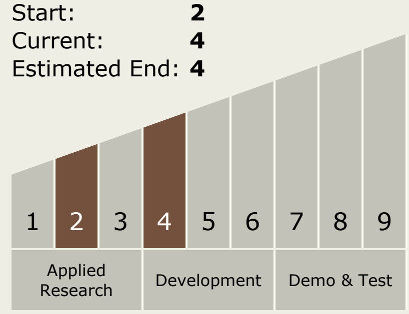
Carlos Torrez

Principal Investigator:

David L Carroll

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**

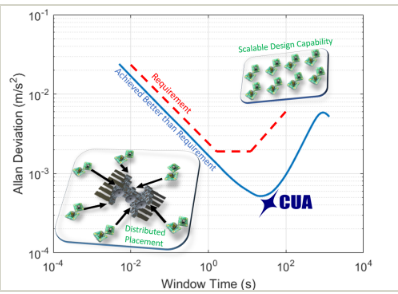


August 2019: Closed out

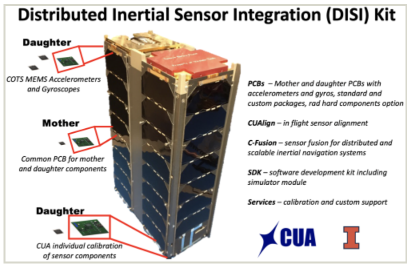
Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137899)*

Images



Briefing Chart Image
Scalable and Distributed Inertial Navigation Systems, Phase I
(https://techport.nasa.gov/image/133526)



Final Summary Chart Image
Scalable and Distributed Inertial Navigation Systems, Phase I
(https://techport.nasa.gov/image/130342)

Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  └ TX17.2 Navigation Technologies
    └ TX17.2.3 Navigation Sensors

Target Destination

Earth